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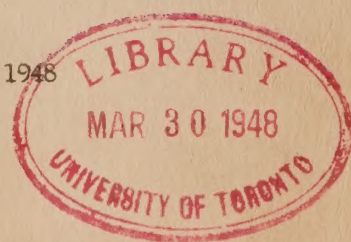
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Summary of the Reports
of the
Commission's Consultants
Concerning
The Problem of Frequency Standardization
in
The Southern Ontario System
of
The Hydro-Electric Power Commission
of Ontario

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PRESENTED TO
THE JOINT CONVENTION
of the O.M.E.A. and A.M.E.U.
TORONTO - - - MARCH 1st-3rd, 1948



SUMMARY OF THE REPORTS OF THE COMMISSION'S CONSULTANTS
CONCERNING
THE PROBLEM OF FREQUENCY STANDARDIZATION IN
THE SOUTHERN ONTARIO SYSTEM OF
THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO

Under date of November 1946, the Commission issued an interim report entitled "Interim Report on a Proposal to Standardize Frequency at 60 Cycles for The Southern Ontario System". This report summarized the results of studies carried out by the staff of the Commission into the estimated costs and financial factors involved in a program of frequency standardization in its Southern Ontario System.

Issued to all cooperating municipalities, it was later the subject of discussion at special meetings held in each district of the O.M.E.A. A special committee of the A.M.E.U. subsequently was appointed, to confer with the staff of the Commission and to study the more detailed reports upon which were based the conclusions presented in the interim report. Additional information was placed before that committee, particularly with reference to estimated long-term future power costs, all of which it is understood was in turn submitted to the various officers of the municipal Commissions.

In brief, the interim report presented an estimate of the total gross cost of frequency standardization of \$195,312,000. It discussed certain factors which favour the adoption of a standard frequency of 60 cycles in Southern Ontario, and summarized certain financial and other advantages which naturally would result from such standardization.

Of this total gross expenditure, \$51,812,000 was estimated as being required to convert the bulk power generating, transmission and transformation facilities, \$35,300,000 to convert the distribution systems of the municipalities, and \$108,200,000 to convert the utilization devices of the various classes of consumers. The report proposed that the first and third of these components should be financed by the Commission, but that the municipalities themselves should each finance the cost of converting its own distribution system.

The report presented also a tentative plan by which the expenditures proposed to be borne directly by the Commission could be financed. It was proposed that the monies required should be drawn from four principal sources, as follows:-

- (a) That part of the expenditure, representing new physical assets required for 60-cycle operation, should be capitalized.
- (b) That part of the expenditure should be drawn from existing reserve accounts, representing excess accumulations during the war years.
- (c) That power rates should be maintained at 1945 levels, the excess revenue thus accumulated in the immediate future years being allocated to the conversion expenditures.
- (d) That the balance of the funds required should be derived from an assessment included in the Commission's cost of power, the amount of which it was estimated would not exceed 5 per cent of the 1945 average wholesale power cost.

Since the presentation of this interim report, the development of the technical and financial aspects of this problem has been continued by the Commission's staff. In addition, consulting advice has been secured and additional reports made available for the guidance of the Commission, as follows:

- (1) The Stone & Webster Engineering Corporation has investigated the technical problems and has submitted a comprehensive report concerning the estimates of cost, a program by which conversion could be carried out, and estimates of the financial and other advantages which would accrue to the Commission, the municipalities and the consumers by such conversion.
- (2) Clarkson, Gordon & Company has investigated the financial problems and has reported on the effect of the proposed program on the existing financial reserves and the future cost of power, and has presented a revised plan by which the total expenditure could be financed.
- (3) Mr. H. Hobson, until latterly Chairman of the Central Electricity Board of Great Britain, and who has had first-hand experience of the extensive program of frequency standardization in England, has, from time to time, conferred with the other two organizations and has presented a report analyzing their proposals in the light of his own personal experience.

Before proceeding to briefly summarize the contents of these reports and to present the conclusions that have been drawn therefrom, it should perhaps be stated that the gross total estimate of cost

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previously presented in the Commission's interim report has been substantiated; that the general conclusions regarding the economics of conversion previously stated have been proven to be as accurate as can be expected under such long-term engineering analysis; and that a plan of financing has been devised which should overcome most, if not all, of the objections previously voiced, most particularly those directed against the proposed cost-of-power assessment, which has been eliminated.

THE STONE & WEBSTER ENGINEERING
CORPORATION'S REPORT

The Stone & Webster report, presented to the Commission under date of December 23, 1947, has been prepared following ten months of study by a qualified engineering group, working for the most part in the offices of the Commission, in direct association with the Commission's own staff.

It states that the information upon which it is based was drawn from the Commission's earlier reports, from general information on system characteristics and operation, from a survey of ten industrial plants, from staff conferences, from reports prepared by the Canadian Manufacturers' Association, and from general equipment prices supplied by the manufacturers.

The report logically may be divided into four subject headings, and is discussed in the following paragraphs on that basis.

(1) ESTIMATES OF GROSS EXPENDITURES REQUIRED

The gross total cost of conversion, based on the program commencing in 1948 and extending over a 15-year period to 1963, is estimated to be \$191,004,500.

The growth of load assumed is that agreed upon in consultation with the Commission, and is such as to result in a total Southern Ontario System load in 1952 of 2,300,000 kw, and an average rate of growth throughout the conversion period of 60,000 kw per year. The total 25-cycle load calculated to be converted on this basis is 1,540,000 kw, excluding 455,000 kw of heavy industrial load in the Niagara area and at Hamilton, the conversion of which is assumed to be deferred.

Calculations are included to indicate that somewhat different load growth assumptions would not have materially affected the economic conclusions, providing only that the rate of conversion is adjusted so as to complete the program in the same period.

Varying the conversion period within limits also is calculated to have no material affect on the comparisons presented, providing only that its commencement is not delayed. Extending the period somewhat would increase the costs, but also correspondingly the savings; shortening the period would increase the difficulties of maintaining the program, particularly in the earlier years.

This estimated gross expenditure is subdivided:

Conversion of Commission-owned generating, transmission, transformation and distribution facilities and Eastern contract generation-- (\$10,755,800)	- \$ 37,670,300
Conversion of municipally-owned transformation and distribution facilities	- 20,586,200
Conversion of consumers' equipment and appliances--	
Domestic	- 54,658,000
Commercial	- 13,104,000
Industrial	- 64,986,000
	<u>\$ 191,004,500</u>

The variations in these figures from those submitted in the Commission's interim report are accounted for:- first, by the revision of all estimates to an April 1947 cost basis; and second, by reason of the more detailed analysis given all estimates in the light of additional information made available by technical studies, cooperation with manufacturers, the municipalities and others.

The substantial reduction in the cost of converting municipal facilities arises largely from new information indicating that a substantial proportion of the existing substation transformers may be used without rewinding, whereas earlier estimates assumed all would need rewinding or replacement.

(2) REDUCTION OF GROSS EXPENDITURES TO NET EXPENDITURES

Certain of these gross expenditures effect capital savings in the systems of both the Commission and the municipalities. Others result either in extending the useful life of existing equipment; or in increasing its capacity, not only in the power supply facilities but also in certain equipment of the consumers.

The Stone & Webster report evaluates these various components of the gross cost and arrives at a NET expenditure for conversion--i.e., a residual expenditure, the economic justification for which depends on the savings and benefits resulting from the adoption of a frequency standardization program. This net cost is derived as follows:

TOTAL GROSS CONVERSION EXPENDITURE		\$ 191,004,500
ESTIMATED VALUE OF EXPENDITURES THAT MAY BE CAPITALIZED BY THE COMMISSION AND THE MUNICIPALITIES		
(a) For additional equipment required for conversion	- \$ 9,598,300	
(b) Value of additional capacity secured by rewinding etc.	- 5,690,700	
(c) Value of equipment released for future service	1,776,200	\$ 17,065,200
ESTIMATED VALUE OF EXTENDED LIFE SECURED BY REBUILDING THE EQUIPMENT OF THE COMMISSION, THE MUNICIPALITIES AND THE CONSUMERS ETC.		<u>54,932,300</u>
		\$ 71,997,500
NET EXPENDITURE		<u><u>\$ 119,007,000</u></u>

(3) SAVINGS EFFECTED BY CONVERSION

The problem of establishing equitable values for the savings that would result to the Commission, to the municipalities and to the consumers, if frequency standardization were undertaken, has been one of the most difficult of all the problems involved in this investigation.

Certain savings have been obvious--as, for example, the lower cost of 60-cycle motors; others have been less obvious--as, for example, the additional market for surplus or secondary energy; still others, while more or less obvious, have been extremely difficult to evaluate--as, for example, the advantages of having newly developed 60-cycle equipment available more promptly, particularly in industry.

The Stone & Webster report carefully analyzes these various savings, which, in all cases, are conservatively stated and evaluated.

They are subdivided into those which accrue directly to the Commission, directly to the municipalities and directly to the consumers. They are further subdivided into those which accrue during the conversion period, and those which will continue to accrue after the conversion program is completed.

Each estimated saving is calculated for the year in which it is effected, based on the proportion of the overall program carried out in that year. Such detail cannot be tabulated in this summary, which will be limited to the combined figures; first, for the savings accruing during the conversion period; and second, for the 20-year period following conversion.

SAVINGS DURING THE CONVERSION PERIOD (1948 TO 1963)

(a) By reason of reduced capital expenditures required to supply the growth load	\$32,466,300
(b) Additional revenue secured from sale of secondary or surplus energy	<u>14,240,000</u>
	<u>\$46,706,300</u>

SAVINGS IN THE EIGHTEEN-YEAR PERIOD
FOLLOWING CONVERSION (1964 TO 1981)

(a) By reason of reduced capital expenditures required to supply the growth load	\$108,147,300
(b) Additional revenue secured from sale of secondary or surplus energy	<u>32,400,000</u>
	<u>\$140,547,300</u>
 TOTAL OF ESTIMATED SAVINGS TO THE COMMISSION, THE MUNICIPALITIES AND THE CONSUMERS (1948 TO 1981)	 <u><u>\$187,253,600</u></u>

This summation of the savings resulting from frequency standardization includes only those which can be evaluated in monetary terms. Certain other benefits of a less tangible nature result, which are difficult or impossible to so evaluate, but which are no less real and certainly have an important bearing on the frequency standardization proposal.

These benefits include the advantages to industrial and other consumers of the greater availability of equipment, and of research developments largely undertaken at 60 cycles; the advantages arising from more flexible interconnections with other systems; the factor of national defence; the elimination of the difficulties of establishing industries, or relocating industrial and other consumers in areas of different frequency; and the substantial advantage of the higher frequency in the lighting field.

4. DEVELOPMENT OF ECONOMIC COMPARISON

The various figures quoted above permit of an economic comparison of the net expenditures required for conversion with those savings and benefits resulting therefrom which can be evaluated in monetary terms, proper interest allowance being made in both cases.

As the conversion period itself extends over a period of 16 years, and a further period of some 18 years is required to complete liquidation of the expenditure, some common point in time must be selected at which the comparison of expenditures and savings is made. Stone & Webster has selected the end of the conversion period, or January 1, 1964, as such a suitable point.

During the conversion period, interest has been allowed on the excess of expenditure over saving in each year, at the rate of $3\frac{1}{2}$ per cent per annum. Following the conversion period, the annual continuing savings are discounted at the same rate of interest to their value at the comparison date.

These various calculations result in the following summarized comparison:

TOTAL GROSS CONVERSION EXPENDITURE	\$191,004,500
Less expenditures capitalized by the Commission and the Municipalities, or recovered by them and by the consumers in the value of extended life	<u>71,997,500</u>
TOTAL NET CONVERSION EXPENDITURE	119,007,000
Less savings to the Commission, the Municipalities and the Consumers during the conversion period	<u>46,706,300</u>
NET CONVERSION EXPENDITURE AS AT JANUARY 1ST, 1964	72,300,700
Plus annual interest accrued during conversion period	<u>27,953,300</u>
NET CONVERSION COST AS AT JANUARY 1ST, 1964	<u>\$100,254,000</u>
GROSS TOTAL VALUE OF SAVINGS 1964 TO 1981 INCL.	\$140,547,300
Less discount to reduce to present worth as at January 1st, 1964	<u>38,851,300</u>
NET VALUE OF 18-YEARS' SAVINGS AS AT JANUARY 1ST, 1964	<u>\$101,696,000</u>
EXCESS OF SAVINGS OVER EXPENDITURES BOTH REDUCED TO JANUARY 1ST, 1964	<u><u>\$ 1,442,000</u></u>

The various estimates of expenditures and savings summarized above, together with the benefits which have not been evaluated, are the bases of the concluding statements in the Stone & Webster report quoted verbatim as follows:

“Costs and savings as estimated in this report are based on April, 1947 price and labor cost levels. However, since changes in these factors will affect both conversion costs and the resultant savings, it is believed that the figures given for these items represent the financial scope of the work as accurately as is possible in any such long term projection and indicate that the net cost of the conversion can be recovered by general savings in from 15 to 20 years after conversion is complete.”

“There are not insurmountable difficulties to the execution of the proposed conversion program from a technical point of view, and other conversions of somewhat similar character have been made with success.”

“The inhabitants of the Niagara Division will be increasingly handicapped by inherently greater power costs and by many indeterminate factors if the conversion is not made.”

“It is therefore recommended that the proposed conversion program be adopted and started as quickly as possible assuming, of course, that it is feasible to finance the expense.”

THE REPORT OF CLARKSON, GORDON & CO.

The Clarkson-Gordon report, submitted to the Commission under date of January 27, 1948, reviews the program of frequency standardization proposed in the Stone & Webster report, develops a proposal under which that program could be financed and discusses that proposal in the light of its effect on reserve funds of the Commission and of the municipalities and upon their respective power rates.

All its basic information, as to estimates of gross expenditures required and as to the savings and benefits resulting therefrom, is taken directly from the Stone & Webster report. Certain additional costs of system expansion, operating costs, revenues, reserves and debt maturities were obtained from the Commission's staff and records.

In considering this report, it is necessary to differentiate clearly between its fundamental method of approach and that of the Stone & Webster report. The Stone & Webster approach is essentially that of an engineering economic analysis and views the problem from the overall standpoint. The estimates of net expenditures and net costs, which have been summarized earlier herein, therefore include, not only the savings effected in the systems of the Commission and the municipalities, but also those effected directly by the ultimate consumers.

On the other hand, the Clarkson-Gordon approach is from the standpoint of the financial problems imposed on the Commission and the municipalities. It therefore is concerned primarily with the savings directly effected by the Commission and the municipalities. Those savings which

accrue directly to the consumers, and which at no time appear as liquid funds within the control of the Commission or the municipalities, do not appear in their financial summaries. This variation is fundamental to the purpose of the reports, but will not cause confusion if the purpose of the analysis is kept clearly in mind.

The Clarkson-Gordon report presents a proposal for the financing of the expenditures required, discusses the effect of that proposal on the future costs of power and on the future financing of the Commission and the municipalities, and briefly reviews new legislation that would be needed to make the frequency standardization proposals legally effective. In the following paragraphs, its contents are summarized under these respective headings.

1 - PROPOSED PLAN OF FINANCING

Of the estimated total gross expenditure (\$191,004,500), \$20,586,200 is estimated to be required to convert the systems of the municipalities, and \$170,418,300 to convert the systems of the Commission, the Eastern contract generation and the equipment and appliances of the various classes of consumers. It is proposed that the former expenditure be financed by the municipalities concerned, and that the financing of the latter expenditure be the responsibility of the Commission.

(A) MUNICIPAL FINANCING

The financial picture in regard to municipal expenditures is summarized as follows:

ESTIMATED TOTAL GROSS EXPENDITURE		\$ 20,586,200
Less:		
Value of increased capacity, new or released equipment arising from conversion	\$ 3,205,900	
Value of extended life of equipment secured by rebuilding	<u>5,716,400</u>	<u>8,922,300</u>
NET EXPENDITURE CHARGEABLE TO CONVERSION		\$ 11,663,900
Less:		
Net reduction in growth capital expen- ditures during the conversion period		<u>706,200</u>
TOTAL NET CONVERSION EXPENDITURE AS AT JANUARY 1ST, 1964		\$ 10,957,700
Plus interest accruing during the conversion period		<u>4,026,300</u>
NET CONVERSION COST AS AT JANUARY 1ST, 1964		\$ 14,984,000
		<u><u> </u></u>
GROSS TOTAL VALUE OF SAVINGS 1964 TO 1983 INCL.		\$ 19,975,000
Less discount to reduce to present worth as at January 1st, 1964		<u>5,603,400</u>
NET VALUE OF 20-YEAR SAVINGS AS AT JANUARY 1ST, 1964		\$ 14,371,600
		<u><u> </u></u>
NET COST TO MUNICIPALITIES AS AT JANUARY 1ST, 1964 (after deducting estimated savings to 1983)		\$ 612,400
		<u><u> </u></u>

It will be noted, that the direct savings accruing to the municipalities during, and in the twenty-year period following conversion, virtually equal the gross expenditure, due account being taken of interest in both cases. The municipal expenditures therefore, taken in total, are shown to be self-liquidating.

The Clarkson-Gordon report proposes that the municipal expenditures be financed on the following basis:

- (a) That the value of increased capacity, and of new and released equipment be capitalized.
- (b) That the value of extended life of equipment secured by rebuilding be charged to the depreciation reserves established against this equipment.
- (c) That the balance of the gross expenditures be financed out of the accumulated operating surpluses of prior years.

It is proposed that debentures be issued to cover capitalized expenditures, and to replace such reserve funds and/or accumulated surpluses as may be necessary due to their previously having been invested in capital plant extensions.

The financial position of the municipalities taken as a group is stated to be strong, and the belief is expressed that the municipalities should be able to pay for the cost of converting their own distribution systems.

(B) COMMISSION FINANCING

The financial picture in regard to the balance of the total gross expenditures, as it directly affects the Commission, is summarized as follows:

ESTIMATED TOTAL GROSS EXPENDITURE		\$ 170,418,300
Less:		
Value of increased capacity, new or released equipment arising from conversion	\$ 12,650,700	
Value of extended life of equipment secured by rebuilding	<u>6,322,600</u>	<u>18,973,300</u>
NET EXPENDITURE CHARGEABLE TO CONVERSION		\$ 151,445,000
Less:		
Net reduction in growth capital expenditures during the conversion period	\$ 11,703,900	
Additional revenue from sale of surplus energy	<u>14,240,000</u>	<u>25,943,900</u>
TOTAL NET CONVERSION EXPENDITURE AS AT JANUARY 1ST, 1964		\$ 125,501,100
Plus interest accruing during the conversion period		<u>43,265,700</u>
NET CONVERSION COST AS AT JANUARY 1ST, 1964		<u>\$ 168,766,800</u>
GROSS TOTAL VALUE OF SAVINGS 1964 TO 1983 INCL.		\$ 51,469,000
Less discount to reduce to present worth as at January 1st, 1964		<u>14,349,600</u>
NET VALUE OF 20-YEAR SAVINGS AS AT JANUARY 1ST, 1964		<u>\$ 37,119,400</u>
NET COST TO COMMISSION AS AT JANUARY 1ST, 1964 (after deducting estimated savings to 1983)		<u>\$ 131,647,400</u>

This "NET COST" represents the extent of the financial problem with which the Commission is confronted. It is the cost which must be borne by the Commission until such time as it is retired, directly or indirectly, out of savings and benefits which accrue to the ultimate consumers.

It will be noted that the net expenditure chargeable to conversion is estimated at \$151,445,000, after deducting from the estimated gross expenditure amounts totalling \$12,650,700, which it is proposed to capitalize, and \$6,322,600, chargeable to the renewals reserve.

The financing proposal included in the report is based on the following six sources of conversion funds:

Appropriation from Contingency Reserves

As at October 31, 1946, the Commission's reserves for contingencies and rate stabilization in the Southern Ontario System totalled \$68,778,482. Clarkson-Gordon have estimated that these reserves will be increased as a result of the 1947 operations by \$12,958,000, and propose that an additional \$5,302,090, previously charged against the contingencies fund for the writing-off of certain intangible assets, be restored. The combined reserves therefore would total \$87,038,572 at November 1, 1947.

After a detailed study of the possible demands upon the rate stabilization reserve and of the demands that logically might be anticipated against the contingencies reserve, Clarkson-Gordon propose that, of the above combined total, \$32,000,000 be maintained for rate stabilization and \$10,000,000 for other contingencies, leaving a balance of approximately \$45,000,000 available for meeting the costs of conversion.

Maintenance of Existing Power Rates

Power costs were analyzed in the light of existing conditions and in the light of conditions which may be anticipated in the future, as is summarized in later paragraphs. Revenues accruing to the Commission by maintaining the cost of power at 1946 levels are estimated to exceed ordinary expenses in the years 1948 to 1951 by \$20,000,000.

Additional Revenues from Surplus Power

Standardization at 60 cycles in Southern Ontario will expand the market for surplus hydro-electric energy existing in the system from time to time. Additional revenues therefore would accrue to the Commission from this source--revenues which would not be available if standardization were not undertaken. These additional revenues are estimated at \$14,240,000 during the conversion period.

Contribution from the Larger Industrial Consumers

Clarkson, Gordon & Co. have considered it equitable that certain consumers should make a direct contribution to the cost of frequency conversion, the contribution bearing some relationship to the benefits that these consumers would receive by reason of the life of their equipment having been extended in the course of conversion.

After consideration of the various classes of consumers, and of the benefits accruing to each, it is concluded that only the larger industrial customers should be required to contribute. A basis for such contribution is presented, based on the number and ratings of the motors actually rewound or replaced in each consumer's premises.

Such contributions are limited, by relieving of any contribution all consumers who otherwise would be required to pay \$250 or less, a proposal which eliminates approximately 75 per cent of all industrial and commercial power consumers, whose aggregate demand is relatively small.

It is proposed that such contributions be payable in five equal annual instalments, without interest, commencing one year following the conversion of each consumer's equipment. A total of \$18,000,000 is estimated to be collectible in this manner.

Interest Improvement

Interest accumulations on the amounts provided in the several ways indicated above, until they are required, are estimated at \$12,031,300 during the conversion period, the interest rate assumed being $3\frac{1}{2}$ per cent per annum.

Funding

After allowance for the monies estimated to be derived from the sources outlined above, a balance of \$46,000,000 is required to complete conversion. This amount it is proposed to fund, at such times during the conversion program as may be necessary. It is estimated that this amount would be fully recovered within 20 years following completion of conversion, from savings in the expansion of the system and from increased revenues from the sale of surplus energy.

Summary of Commission Financing

A summary of the proposals for financing the Commission's net expenditure for conversion follows:

Appropriation from contingencies reserves	-	\$45,000,000
Available by maintaining the cost of power at 1946 levels	-	20,000,000
Additional revenues from the sale of surplus energy during the conversion period	-	14,240,000
Contribution from the larger industrial consumers	-	18,000,000
Interest accumulations	-	12,031,300
Balance to be funded	-	<u>46,000,000</u>
		\$155,271,300
Net expenditure chargeable to conversion	-	<u>151,445,000</u>
Margin in excess of estimated net expenditure	\$	<u><u>3,826,300</u></u>

It may be noted that this proposal does not include any direct levy in the municipalities' cost of power, such as was proposed in the Commission's interim report.

2. EFFECT OF FINANCING PROPOSALS ON POWER COSTS

The tabulation included previously, setting forth the financial picture as it affects the Commission, indicates the "NET COST" to the Commission of frequency standardization, as at January 1, 1964, as being \$131,647,400 (after deducting the estimated savings to the Commission to 1983). This figure includes an overall saving on account of rural conversion, the net cost to the Commission, excluding rural, being a slightly higher figure, namely \$134,110,900. It is this net cost which must be reflected, directly or indirectly, in the Commission's cost of power to the municipalities.

The Clarkson-Gordon financing plan includes no direct levy in the Commission's cost of power to the municipalities (except to the extent that power costs are proposed to be maintained, for other reasons, at the 1946 level until 1951) and therefore it may be considered that no direct increase in the Commission's cost of power to the municipalities results from the conversion program.

The indirect effect, calculated as an average over the conversion period plus the 20-year period thereafter, is stated as being the above net cost divided by the average annual horsepower estimated to be sold during the 36-year period.

Net cost of conversion at January 1st, 1964	-	\$134,110,900
Average annual horsepower estimated to be sold during 36-year period 1948-1983	-	3,423,000 hp
Average cost per horsepower per year	-	<u>\$1.09</u>

For comparison, it may be stated that Stone & Webster estimated the savings to consumers, from extended life through rebuilding or replacing their equipment and from savings on the purchase of new equipment during and in the 20 years following the conversion period. These estimates, adjusted for interest to January 1st, 1964, amount to \$135,486,500, slightly exceeding the above net cost to the Commission as at that date.

3. TREND IN FUTURE POWER COSTS

Clarkson, Gordon & Co. have reviewed the probable trend in the cost of power over the next twenty years on the basis of the estimated future loads and plans for expansion established for the purpose of these reports.

The average cost of power in 1946 was \$20.92 per horsepower, including a special charge for contingencies of \$4.03 per horsepower, the net cost being \$16.89 per horsepower. This latter figure is abnormally low, due to the fact that the system is supplying loads substantially in excess of the rated capacity of the presently existing facilities. Were the system loads such as could be satisfactorily supplied by the existing facilities, it is calculated that the actual average cost of power would approximate \$19.50 per horsepower.

Power costs are estimated to trend upwards in future years. At 1954, when the currently planned program of new construction is completed, it is estimated that the overall average cost of power will approximate \$22.00.

At 1964, it is assumed, for the purpose of this study, that the St. Lawrence development will largely have been completed, with its associated transmission and power distributing facilities. With the addition of these facilities, it is estimated that the average overall cost of power would amount to from \$21.00 to \$22.00 per horsepower: however, at 1964, the elimination of interest and sinking fund charges on certain of the original capital expenditures will operate to reduce power costs by an average of approximately \$2.00 per horsepower, or to slightly less than the 1946 figure of \$20.92.

It will be noted, then, that the estimated trend in power costs is such that costs may initially slightly exceed the 1946 charges, thereafter tending slightly downwards, if a relatively low cost development at the St. Lawrence becomes available. Without the St. Lawrence, it may be surmised,

though this statement is not included in the Clarkson-Gordon report, that this downward trend may not be evident.

4. EFFECT OF PROPOSALS ON FUTURE FINANCING

The financing of any proposed program of frequency standardization obviously must be coordinated with the financing of the capital expenditures required for system expansion. Particularly is this true during the next few years when the expansion program of the Commission is of such magnitude as to exceed anything so far undertaken.

Clarkson-Gordon have analyzed the estimated future financial requirements of the Commission for system expansion, debt maturities etc. and, after deducting funds expected to be available from sinking fund provisions etc., have arrived at net requirements on this account as summarized below:

	<u>Southern Ontario System</u>	<u>Northern Ontario Properties</u>	<u>Net Additional For Conversion</u>	<u>Total</u>
1948-51	\$222,203,000	\$21,627,100	\$29,774,400	\$273,604,500
1952-63	<u>102,678,500</u>	<u>(Not estimated)</u>	<u>81,326,700</u>	<u>184,005,200</u>
	\$324,881,500	\$21,627,100	\$111,101,100	\$457,609,700

It will be noted that the financing of the new capital requirements between 1948 and 1951 will be a problem of substantial proportions, though augmented by only 12 per cent additional on account of frequency conversion. In subsequent years, the proportionate weight of the conversion program is greater, but the total estimated annual requirements are substantially less and should not present a serious problem.

5. LEGISLATION REQUIRED

The Clarkson-Gordon report briefly reviews the new legislation that probably will be required to make the proposals for frequency standardization, and for the financing of the cost thereof, effective. It is suggested that the following amendments may be needed in the Power Commission Act or otherwise:

- (a) That power may be supplied, by the Commission and by the municipalities, at a frequency other than that specified in existing contracts.
- (b) That the Commission may expend monies for the conversion of its own works and of works and equipment owned by others.
- (c) That the municipalities may expend monies for the conversion of their own works.
- (d) That a frequency standardization reserve may be established, with authority to allocate to this reserve funds from sources outlined in their report.
- (e) That charges may be made to certain consumers for conversion of their equipment.
- (f) That the income of the Commission may be applied to meet frequency conversion costs.

REPORT OF MR. HAROLD HOBSON

Mr. Hobson's position in these investigations has been that of an individual engineering consultant; one having a wide and varied background of experience, including first-hand experience of the frequency standardization program in Great Britain, carried out by the Central

Electricity Board (commonly known as "The British Grid") of which he was General Manager and later Chairman.

He has conferred, during two visits to this Continent, with the Stone & Webster and Clarkson-Gordon organizations, as well as with the Commission's staff, and his report, dated February 16, 1948, is stated to be made following studies of the reports of the other consultants.

The frequency standardization program carried out in Great Britain between 1929 and 1936 is discussed, and its primary justification stated to be the integration of the then existing means of energy production. Standardization was effected at a cost of some \$75,000,000, an expenditure considered to be more than offset by the direct benefits of production integration. No attempt was made to establish and evaluate those other and lasting benefits which would accrue to the consumers.

Because of these direct benefits, which would be shared by virtually all consumers, the cost of conversion was funded on a 40-year basis, and the annual charges levied against all distributing authorities. As consumption has increased, the unit cost of this levy has decreased, and now represents approximately 0.15 mills per kilowatthour.

This method of financing has not proved burdensome, as it has coincided with a steep downward trend in energy production costs. At no time, therefore, has it been responsible for an increase in rates; it has merely retarded, to a small extent, the downward movement.

Mr. Hobson discusses, with some care, the difference between the technical situation which existed in Great Britain and that now existing in Southern Ontario. The Southern Ontario system is substantially integrated

within itself, frequency changer interconnections providing interchange capacity between the respective 60-cycle and 25-cycle divisions. Furthermore, being predominantly a hydro-electric system, the savings in fuel, which were so important in Great Britain, are not a factor in Ontario. It becomes necessary, therefore, to examine the frequency standardization proposals in detail sufficient to establish the fact that the monetary value of the benefits derived from conversion will offset, within a reasonable period, its initial cost.

Reviewing the Stone & Webster report, Mr. Hobson accepts the proposed conversion program as providing a standard of service, in certain respects, better than that existing, and at a minimum expenditure. It is recognized that the program is flexible and subject to variation as future conditions dictate. The establishment of a Frequency Changeover Department within the Commission is strongly recommended, following the practice adopted in Great Britain (and, incidentally, also by the Niagara-Hudson and Southern Californian interests).

The estimates of capital and other credits established during the conversion period are criticized only to the extent of being considered too conservative. The same opinion is voiced in discussing the savings estimated to continue beyond the conversion period. Particular reference is paid to the load growth assumption (60,000 kw per year), which Mr. Hobson is inclined to consider too conservative, and to the value of frequency standardization in national defence, a factor which was of inestimable importance in Great Britain and which Mr. Hobson here considers to be of "major importance", though impossible of monetary evaluation.

The proposed method of financing the conversion expenditures is the major point arising out of the Clarkson-Gordon report discussed by Mr. Hobson. Again, the conditions which exercise control over the possible methods of financing are contrasted with those which were in effect in Great Britain.

Attention is drawn to our lack of adequate generating capacity and transmission facilities resulting from the war, and to the "artificially low" production costs resulting therefrom. With the correction of this existing situation, at the higher construction costs now ruling, a progressive increase in production costs per horsepower sold is anticipated over the next few years. Mr. Hobson therefore concludes that a direct charge for conversion, such as adopted in Great Britain, necessarily would be reflected in an increased price to consumers.

Reviewing the Clarkson-Gordon proposals as to financing, the report accepts the proposed use of reserve funds and of surplus revenue accumulated in the immediate future years; accepts the principle of a direct contribution on the part of industrial consumers; and accepts the proposed funding of \$46,000,000, a sum which is estimated to be returned out of savings within 20 years from the completion of the conversion program.

In the following paragraphs, Mr. Hobson's "General Conclusions" are quoted verbatim:

"Modern industry throughout the world is becoming increasingly dependent upon electric power and it is therefore vital to Ontario that its system of power supply should in no way lag behind world development. So far as standards of service and prices of energy are concerned, The Hydro-

Electric Power Commission has earned high recognition throughout the world. There can be no doubt, however, that the fact of so large a proportion of its undertaking being operated at a frequency which has been almost universally abandoned constitutes a handicap to industrial expansion and involves the domestic consumer in certain inconveniences and added cost."

"The exhaustive investigations which have now been concluded show clearly that the conversion of the system to 60 cycles in conformity with the rest of the American continent can be carried out without serious dislocation of supplies and that the savings directly attributable to the conversion during some eighteen years following its completion will equal the whole cost of the work. Moreover, the programme of conversion can be financed without any direct increase in the price of power and with a contribution from industrial consumers substantially less than the value of the benefits which they will receive."

"There exist certain circumstances, notably a large expansion programme in the immediate future and a substantial reserve fund built up during the war, which contribute to make the present time particularly favourable to undertake the conversion. Were this opportunity to be missed it is in my view unlikely that a sound financial case for conversion could be made at any time in the future."

"It is therefore my strong recommendation that the conversion programme should be undertaken forthwith on the lines proposed in the two Reports of Stone & Webster and Clarkson, Gordon & Company."

